Remarks

Claims 1-27 are presented for reconsideration. Independent claims 1 and 24 have been amended to better define the claimed invention. (A marked up version of the amended claims is attached.)

The present invention is directed to a bi-directional device which operates as an isolated polarizing optical beam combiner in a first direction, or as an isolated polarizing optical beam splitter in a second direction. As a combiner, such a device is quite important for combining the polarized outputs of a pair of pump lasers and providing isolation to protect the source lasers. By splitting the beam splitting crystal, a bi-directional isolating device is created which is significantly smaller, using fewer components than a separate beam splitter/combiner and an isolator. Advantageously, this provides an efficient and cost effective device for integrating a laser source to a polarizing beam combiner with less loss and smaller size.

Additional advantages are realized in the present invention in placing the beam splitting crystals in object space or image space, rather than passing collimated beams through many times larger crystals, as recited in claim 3. This enables the use of significantly smaller crystals producing a smaller device. Moreover, as recited in claim 11, by including lenses within the device to collimate the beams through the rotators, but return to image space for the birefringent crystal, improved coupling is achieved. Further, by splitting the birefringent crystal into two smaller elements, the optical path lengths for the ordinary and extraordinary rays can be equalized. This eliminates defocusing at the ports and significantly reduces insertion losses as recited in claims 12 and 27.

Turning now to the Office Action, claims 1-27 stand rejected under 35 USC 102 (b) as anticipated by (i.e., lacking novelty over) Xie et al (US 6,175,448). Applicant respectfully requests reconsideration of this rejection.

Xie et al. discloses a circulator, not a beam splitter or combiner. The circulator is a three port device including birefringent crystals and non-reciprocal rotators for polarization diversity and isolation. However, although these components are common to both devices, the configuration of elements, the function of each element and the optical path through the devices are not the same.

Pursuant to §102, in order to anticipate the present invention as claimed, Xie et al. must disclose every limitation found in a rejected claim using claim 1 as the focal point of distinction, it will be seen that claim 1 recites novel subject matter that disclosed in Xie, et al. claim 1 recites (highlighted limitations are not found in Xie, et al. invention.

1. An isolated **polarizing** optical beam splitter/combiner **for combining orthogonally polarized beams of light** into a single port in a combining direction, or **for splitting a beam of light into orthogonally polarized beams of light** to spatially separated ports in a splitting direction comprising:

POINTS OF NOVELTY

The Xie device is not polarizing; it is polarization independent. Xie does not combine orthogonally polarized beams of light, nor split a beam of light into orthogonally polarized beams. The input and output of the Xie device are substantially unpolarized or randomly polarized.

a single port for launching a beam of light into the splitter/combiner, or for outputting a combined beam of light from the splitter/combiner;

a pair of spaced apart ports **for launching orthogonally polarized beams of light** into the splitter/combiner, or **for outputting orthogonally polarized beams of light** from the splitter/combiner;

a first polarization beam splitter optically coupled to the single port, oriented to provide different optical paths for two orthogonally polarized beams of light;

a second polarization dependent beam steering means optically coupled to the pair of spaced apart ports, oriented to provide different optical paths for two orthogonally polarized beams of light;

a non-reciprocal rotator between the first polarization beam splitter element and at least an element of the second polarization dependent beam steering means for rotating a polarization of each of two orthogonal beams of light and **maintaining the orthogonal relationship between them**, said non-reciprocal rotator adapted to be driven for transmission in a selected combining direction or a splitting direction.

FURTHER POINTS OF NOVELTY

Xie uses two pairs of non-reciprocal rotators to rotate both beams to a same polarization state in a first direction and a same other polarization state in a second direction , an orthogonal relationship is not maintained.

wherein, when driven in the combining direction, the non-reciprocal rotator permits light to propagate **from the pair of ports** simultaneously **to the single port**, and prevents light from coupling between the single port and the pair of ports, or

wherein, when driven in the splitting direction, the non-reciprocal rotator permits light to propagate **from the single port** simultaneously **to the pair of ports**, and prevents light from coupling between the pair of ports and the single port.

STILL FURTHER POINTS OF NOVELTY

Xie discloses a circulator that permits transmission from port one to port two, and from port two to port three. No transmission occurs simultaneously from a single port to a pair of

ports, nor simultaneously from a pair of ports to a single port, as claim 1 has been amended to clarify.

Dependent claims 2-23 all include the limitations of claims 1 as a matter of law (35 U.S.C. §112, ¶4) and for the same reasons given above, recite novel subject matter over Xie, without the need to review the additional distinguishing limitations of these dependent claims.

Independent claim 24 as amended further defines the function of the second birefringent crystal, a clear point of novelty over the structure disclosed by Xie. Other distinctions are essentially the same as those identified in claim 1. Claim 24 specifically recites in this respect:

> "a second birefringent crystal having different optical paths for light of orthogonal polarizations converging from a second and a third spaced apart ports for reducing a spatial separation between two co-propagating orthogonal beams of light in the combiner mode, or diverging to the second and third spaced apart ports for spatially separating co-propagating orthogonal beams of light split by the first birefringent element in the splitter mode and having a rotational axis;"

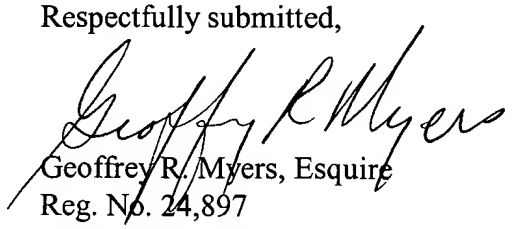
Simultaneous transmission from ports one and three in the Xie device is prevented by the double sets of non-reciprocal rotators which provide isolation in the reverse direction of the circulator.

Dependent claims 25-27 are similarly distinguished from the prior art pursuant to 35 U.S.C. §112, ¶4.

In view of the above, Applicant sincerely believes that this case is in condition for allowance and may be passed to issue forthwith. A holding to this effect is respectfully solicited. If, however, the Examiner believes that any issues remain, he is invited to call Applicants' undersigned counsel to arrange an interview for resolving any such issues.

The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account No: 50-1465.

Respectfully submitted,



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MARKED UP VERSION OF THE CLAIMS

1. **(amended)** An isolated polarizing optical beam splitter/combiner for combining orthogonally polarized beams of light into a single port in a combining direction, or for splitting a beam of light into orthogonally polarized beams of light to spatially separated ports in a splitting direction comprising:

a single port for launching a beam of light into the splitter/combiner, or for outputting a combined beam of light from the splitter/combiner;

a pair of spaced apart ports for launching orthogonally polarized beams of light into the splitter/combiner, or for outputting orthogonally polarized beams of light from the splitter/combiner;

a first polarization beam splitter optically coupled to the single port, oriented to provide different optical paths for two orthogonally polarized beams of light;

a second polarization dependent beam steering means optically coupled to the pair of spaced apart ports, oriented to provide different optical paths for two orthogonally polarized beams of light;

a non-reciprocal rotator between the first polarization beam splitter element and at least an element of the second polarization dependent beam steering means for rotating a polarization of each of two orthogonal beams of light and maintaining the orthogonal relationship between them, said non-reciprocal rotator adapted to be driven for transmission in a selected combining direction or a splitting direction,

wherein, when driven in the combining direction, the non-reciprocal rotator permits light to propagate from the pair of ports **simultaneously** to the single port, and prevents light from coupling between the single port and the pair of ports, or

wherein, when driven in the splitting direction, the non-reciprocal rotator permits light to propagate from the single port **simultaneously** to the pair of ports, and prevents light from coupling between the pair of ports and the single port.

24. **(amended)** An isolated polarizing optical beam splitter/combiner for combining orthogonally polarized beams of light into a single beam of light in a combiner mode of operation, and for splitting a beam of light into orthogonally polarized beams of light in a splitter mode of operation comprising:

a first birefringent crystal having different optical paths for light of orthogonal polarizations converging at a single first port for combining orthogonally polarized beams of light in the combiner mode, or diverging from the single first port for splitting orthogonal beams of light from a beam of light in the splitter mode and having a rotational axis;

a second birefringent crystal having different optical paths for light of orthogonal polarizations converging from a second and a third spaced apart ports for reducing a spatial separation between two **co-propagating** orthogonal beams of light in the combiner mode, or diverging to the second and third spaced apart ports for spatially separating **co-propagating** orthogonal beams of light split by the first birefringent element in the splitter mode and having a rotational axis;

a non-reciprocal polarization rotator disposed between the first and second birefringent crystals for rotating the polarization of orthogonally polarized beams of light to a first state in a transmission direction for optically coupling the first port to the second and third ports, and for rotating the polarization of orthogonally polarized beams of light to a second state in an isolation direction which does not permit coupling between the first port and the second and third ports.